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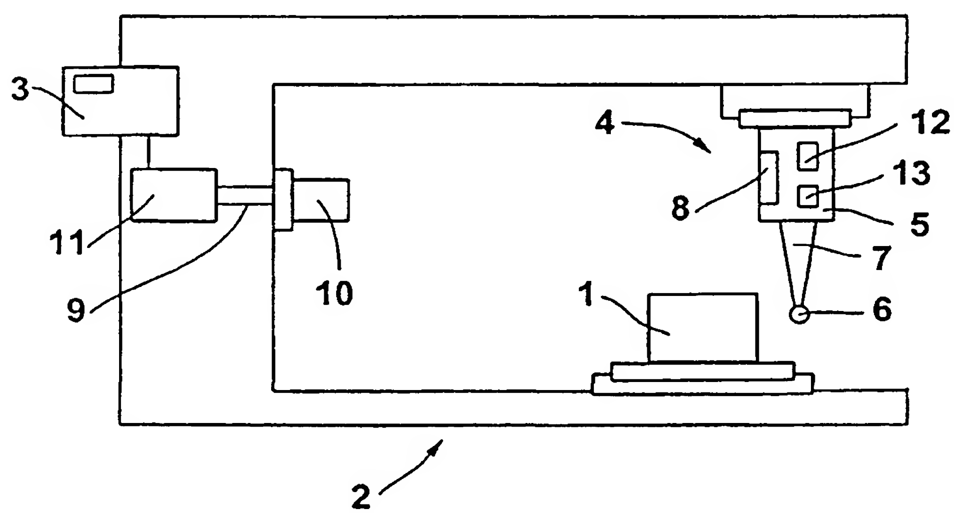

(57) Abstract

A system for detecting linear dimensions of mechanical workpieces (1) includes a checking probe (4) with detecting devices (13), a power supply battery (12) and a remote transceiver unit (8), while a stationary transceiver unit (10) is located at a distance from probe (4) and adapted for wireless transmitting to the remote transceiver unit and wireless receiving from it signals, for example, coded optical signals. More specifically, the stationary unit transmits activation and/or deactivation signals to the probe circuits, and/or the return to a "stand–by" low power for controlling the full power supply of the probe consumption state. The remote transceiver unit includes devices (F2, A2, MF1) adapted for achieving an automatic sensitivity control and other attenuation devices (FA) for preventing unwanted consumption of the probe battery energy due to noise signals, arriving, for example, from fluorescent lamps and causing the improper activation or deactivation of the probe circuits.

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DESCRIPTION

«SYSTEM FOR DETECTING LINEAR DIMENSIONS OF MECHANICAL WORKPIECES, WITH WIRELESS SIGNAL TRANSMISSION UNITS»

Technical Field

The present invention relates to a system for detecting linear dimensions of a workpiece, including a checking probe with detecting devices, a power supply connected to the checking probe, a remote transceiver unit, integral with the probe, connected to the detecting devices and to the power supply, and adapted for wireless transmitting signals indicative of the state of the probe, and a stationary transceiver unit, adapted for wireless transmitting activation signals to the formerly mentioned remote unit, wherein the remote transceiver unit includes receiving devices adapted for receiving the wireless transmitted signals, a processing section, connected to the receiving devices, and to the power supply and adapted for generating an enable signal, a switching unit connected to the processing section and to the power supply, and additional sections connected to the switching unit, the switching unit being adapted for receiving the enable signal and, on the basis of this signal, controlling the power supply of at least some of the additional sections.

Background Art

There are known measuring systems as, e.g. systems in numerical control machine tools, for detecting the position and/or the dimensions of machined workpieces by a contact detecting probe, mounted in the machine, that, in the course of a checking cycle, displaces with respect to the workpiece, touches the surfaces to be checked and responds to contact by wireless transmitting signals to a receiving unit, usually located at a certain distance from the probe.

The receiving unit is in turn connected, by means of an interface device, to the numerical control unit that, by processing other signals indicative of the spatial position of the probe, provides information about the position of the workpiece surfaces.

The contact detecting probe can include electric batteries for the power supply of contact detecting circuits and the wireless transmission devices. The wireless transmission can take place, for example, by emitting electromagnetic signals of optical or radio-frequency type. Since the probe is utilized just for short time intervals during the machining cycle of the machine tool, the associated detecting circuits and transmission devices are normally kept in a "stand-by" state of low power consumption and powered-up only when there is the need to perform a checking cycle. The switching from the "stand-by" state to the full "powered-up" state can be accomplished by controlling suitable switching devices on the probe by means of activation signals wireless transmitted by the receiving unit. When the measuring cycle ends, the probe circuits return to the "stand-by" state of low power consumption either by wireless transmitting a suitable deactivation signal, or, as an alternative, after a predetermined time period has elapsed.

US-A-4779319 discloses a measuring system with these characteristics and more specifically it describes a checking probe with circuits for transmitting optical signals in the infrared band. An infrared radiation flash is utilized for activating the probe, in other words for controlling the full power-up of the probe detecting circuits and the transmission devices.

The probe circuits for receiving the optical activation signal and controlling the connection to the batteries include a receiver diode and a coil that, among other things, serves as a high pass filter for reducing the negative effects due to the steady state and/or low frequency components of the environment illumination and

for excluding from subsequent processings low frequency pulses emitted, for example, by fluorescent lamps located in the probe environment.
However, it may occur that the fluorescent lamps, or other sources of light, emit electromagnetic radiations with frequencies in the same band as the activation or deactivation signals (or, more specifically, the associated modulating signals) and that these radiations cause the unwanted activation of at least some of the probe circuits, and a useless consumption of the battery supply energy, or the unwanted deactivation in the course of a checking cycle and imaginable negative consequences.
A fluorescent lamp can emit improper and unforeseeable radiations, even in the infrared radiation band, that vary depending on the type of lamp, on the environment temperature, on the power supply voltage, on the age and the efficiency conditions of the lamp itself.
Another possible way for probe optical activation (or deactivation) foresees, as an alternative to the pulse signal described in patent US-A-4779319, an infrared radiation signal modulated as a sequence of pulses of a given frequency (for example, about ten KHz) and transmitted to the receiving unit for a determined time period (for example, a few tenths of a second). The probe circuits include a logic section - that is powered when there is detected a signal of sufficient intensity - that checks whether the received signal has the required frequency and minimum duration (a number of pulses generally by far smaller than those actually transmitted) of the activation (or deactivation) signal and that, in the affirmative, causes the power-up of the other probe circuits (or the return to the stand-by state).
The intensity of the radiations randomly emitted by the fluorescent lamps in the frequency band of the activation signal can be sufficient for causing the frequent and needless power-up of the logic section of the probe circuits, and consequently unwanted consumption of the

battery energy. Furthermore, while the logic section is improperly powered, it may occur that a sequence of pulses be sent by a fluorescent lamp whose frequency and duration are the same as those of the activation signal. It may also occur that, while the probe is performing a checking cycle, the logic section detects a sequence of pulses having frequency and duration that match those of the deactivation signal, without the latter signal having actually been transmitted by the receiving unit.

Disclosure of the Invention

Object of the present invention is to overcome the inconveniences, in terms of consumption of the battery supply energy and undesired probe activation or deactivation, caused by fluorescent lamps, or by other sources emitting electromagnetic radiations in the probe environment.

This and other objects are achieved by a system in which the processing section of the remote transceiver unit includes attenuation devices adapted for inhibiting the generating of the enable signal on the basis of attributes of the signal that the receiving devices have wireless received.

Brief Description of the Drawings

The invention is hereinafter described in detail with reference to the enclosed sheets of drawings, given by way of non limiting example only, wherein

figure 1 is a schematic view of a machine tool on which there is mounted a checking probe for detecting linear dimensions of mechanical pieces;

figure 2 is a diagram including some blocks of a known transceiver unit of coded optical radiations;

figures 3 and 4 show the trends of some of the signals generated in the transceiver unit of figure 2 on the arrival of a probe activation signal or a noise signal;

figure 5 is a diagram including some blocks of a transceiver unit of coded optical radiations, according to a first embodiment of the invention;

figures 6, 7 and 8 show the trends of some of the signals generated in the transceiver unit of figure 5 on the arrival of a noise signal, an activation signal or a deactivation signal;

figure 9 is a circuit diagram of a component of the transceiver unit of figure 5, according to a different embodiment of the invention; and

figure 10 is a schematic and partial view of a transceiver unit of coded optical radiations, according to a further embodiment of the invention.

Best Mode for Carrying Out the Invention

Figure 1 illustrates, in simplified form, a system for detecting linear dimensions of a piece **1** on a machine tool, for example a machining center identified in the drawing by reference number **2**, where piece **1** is machined. The system includes a computerized numerical control **3**, for controlling the operation of machine tool **2**, and a detecting apparatus including a checking probe **4**. The latter, for example a contact detecting probe, has a support and reference portion **5** coupled to slides of machine tool **2**, a feeler **6** and an arm **7** carrying feeler **6** and movable with respect to support portion **5**. Moreover, probe **4** includes detecting devices, for example a microswitch **13**, a power supply with a battery **12** and a remote transceiver unit **8** for transmitting infrared optical signals to and receiving infrared optical signals coming from a stationary transceiver unit **10**, located at a distance from probe **4**.

The stationary transceiver unit **10** is connected, through a cable **9**, to an interface unit **11**, in turn connected to the computerized numerical control **3**. The stationary transceiver unit **10** has the function of transmitting coded optical signals to the remote transceiver unit **8** associated with the probe **4**, for activating and deactivating probe **4** in response to the reception of a request sent by numerical control **3** through the interface unit **11**, and receiving, from remote unit **8**, coded optical signals including information about, for example, the spatial position of feeler **6** with respect to support portion **5**, or the level of charge of battery **12** of probe **4**. The terms activation/deactivation mean the switching of the power supply of probe **4** from/to a "stand-by" state in which just some low consumption sections of the remote transceiver unit **8** are powered, to/from a state of "full" power-up of unit **8**.

Figure 2 is a block diagram showing some parts of a remote transceiver unit **8** of a known type. It includes receiving devices with a photodiode **PH**, adapted for receiving the periodic optical signals sent by stationary unit **10**, and generating an alternating signal (for example a current), a processing section **E**, and further sections, with a logic processing unit (or "logic") **L** and circuits for generating and transmitting optical signals. The latter circuits are schematically shown in figure 2 by the block identified by letter **T**, and are achieved in a known way that is not of specific interest to this invention.

In turn, the processing section **E**, connected to battery **12** and characterized by a very low consumption of current, includes an amplifier **A1** connected to photodiode **PH** for generating a signal - for example a periodic signal and more specifically an alternating voltage **VA1** -, and a comparator **C1**, for comparing the amplitude of signal **VA1** with a first threshold value **VTH1** for generating a signal **VC1** consisting of a sequence of pulses with frequency and duration that correspond to those of the periodic signal

that stationary unit **10** sends to photodiode **PH**. Furthermore, processing section **E** also includes a filter **F1** with its input connected to comparator **C1**, and its output connected to a second comparator **C2**, the latter comparing signal **VF1** provided by filter **F1** with a second threshold value **VTH2**. Furthermore, remote transceiver unit **8** includes a circuit **G1** that achieves a logic OR, a circuit **G2** that achieves a logic AND and a switching unit **A** connected to battery **12**, to logic **L** and to circuits **T**.

When photodiode **PH** receives an optical signal arriving from stationary transceiver unit **10**, it generates a signal that is amplified by amplifier **A1** (**VA1** in figure 3), and is compared with threshold value **VTH1** by comparator **C1**. When the amplitude of signal **VA1** is smaller than threshold **VTH1**, output **VC1** of comparator **C1** is at low logic level, while it switches to high logic level when the amplitude of signal **VA1** exceeds threshold **VTH1**. The processed signal **VC1**, provided by comparator **C1** and sent to the input of low pass filter **F1**, is a sequence of pulses having the same frequency and duration (i.e. number of pulses) as the signal transmitted to photodiode **PH**. The signal **VF1**, at the output of filter **F1**, is then compared by comparator **C2** with the threshold value **VTH2**. When signal **VF1**, outputted by filter **F1**, exceeds threshold value **VTH2**, enable signal **VC2**, outputted by comparator **C2**, switches from low to high logic level and, through the logic OR **G1**, enables (**VG1**) switching unit **A** to connect battery **12** to logic **L** in order to provide the latter with the power supply voltage **VA**.

The high logic level of signal **VC2**, through the enable device achieved by means of the logic AND **G2**, also enables the transmission of the processed signal **VC1** to logic **L**, for checking the frequency and the duration of the signal **VC1** and, consequently, of the signal received by photodiode **PH**. If the detected frequency and duration (i.e. the minimum number of pulses) correspond to those of the activation signal, logic **L** places the signal **VL** at high logic level for controlling switching unit **A** to power

supply the generating and transmitting circuits **T** and concurrently, through logic OR **G1**, keeps logic **L** powered even after the activation signal ends and signal **VC2** switches to low logic level.

Logic **L** brings signal **VL** back to low logic level when the photodiode **PH** receives a deactivation signal, that logic **L** recognizes by identifying the frequency and the duration (minimum number of pulses) of the corresponding signal **VC1**. As an alternative, the switching of signal **VL** to low logic level can be controlled when the time set in a timer, achieved in a known way in logic **L** and not shown in the figures, elapses. When signal **VL** switches to the low logic level, switching unit **A** is actuated for inhibiting the power supply of circuits **T** and, when the received signal is no longer present, logic **L**.

Figure 3 shows the trends of the above mentioned signals when the circuits of probe **4** are in a stand-by state and photodiode **PH** receives an activation signal transmitted by stationary unit **10**. It should be realized that, for the sake of clarity, the unit of division of the time scale in the first two graphs in figure 3, relating to signals **VA1** and **VC1**, is of approximately two orders of magnitude smaller than the unit of division of the other graphs (for example: one millisecond in the first two graphs, as compared to one tenth of a second in the other graphs). In this connection, it should be realized that the dimensioning of filter **F1**, and more particularly its associated time constant RC1, is such that signal **VF1** reaches and exceeds threshold value **VTH2** of comparator **C2** only after a sequence of some hundredths of pulses of signal **VC1**. In practice, the stationary transceiver unit **10** transmits an activation (or deactivation) signal with a very high number of pulses (in the range of some thousandths), and logic **L** must identify just a limited sequence thereof (normally just a little more than about ten pulses). For the same reason, the first two graphs of

figure 3, specifically those relating to signals **VA1** and **VC1**, have interruptions.
The function of filter **F1** and comparator **C2** is to power supply logic **L** only when the mean value of signal **VC1** outputted by comparator **C1** or, more specifically, its "duty-cycle" (i.e., the ratio between the time - within a cycle - in which said signal assumes a high logic level and the duration of the whole cycle), exceeds a specific value in a rather long time interval, thereby monitoring that photodiode **PH** has received a signal that exceeds the minimum predetermined values in terms of intensity and duration. In this way it is possible to prevent a needless consumption of the battery supply energy when there are pulse optical noises or activation signals that are too weak for being correctly processed by logic **L**.
In the event that fluorescent lamps, or other sources of electromagnetic waves near probe **4**, emit accidental and unforeseeable infrared radiations, the intensity and duration of such radiations can be sufficient for keeping logic **L** powered up for long periods (i.e. **VA** remains at high logic level), and cause a consequent considerable increase in the consumption of energy of battery **12**.
Figure 4 shows the trends of the same signals that are shown in figure 3, under the circumstance wherein photodiode **PH** receives a signal that is not identified by logic **L** as an activation/deactivation signal (for example, a noise signal, the end of which is not shown in figure 4). These signals have the same trend as those previously shown, but in this case, signal **VL**, outputted by the logic **L**, remains at low logic level. According to what is shown in figure 4, when the intensity of the signals received by photodiode **PH** remains greater than a predetermined value logic **L** remains powered for identifying the frequency and the duration of the received signal. As a consequence, there is a consumption of energy of battery **12** even at times when the circuits could remain in a stand-by state.

Figure 5 is a block diagram showing some parts of a remote transceiver unit **8** according to a first embodiment of the invention.

The processing section **E** includes, in addition to the components described with reference to figure 2, attenuation devices that achieve an automatic sensitivity control and that, in the illustrated example, include elements of a feedback circuit, more specifically an additional low pass filter **F2**, the input of which is connected to the output of comparator **C1**, an additional amplifier, for example a differential amplifier, **A2**, connected to the output of filter **F2**, and a field effect transistor, or MOSFET (Metal Oxide Semiconductor Field Effect Transistor) **MF1** of the enhancement mode type that achieves an attenuation device. The zones of transistor **MF1** known as "gate", "source" and "drain" are connected to the output of amplifier **A2** and at the ends of photodiode **PH**, respectively.

The signal **VC1**, outputted by comparator **C1**, is sent to the input of filter **F2** that, as more detailedly described hereinafter, also provides a delay generator, having a time costant RC2 longer than that (RC1) of filter **F1**. The output signal **VF2** is compared with a threshold value **VTH3**, lower than **VTH2**, and amplified for providing a signal, more particularly a voltage **VA2** that is sent to the gate of transistor **MF1**. Voltage **VA2** controls, in an analogue or continuous way, the conduction of transistor **MF1** and the consequent, partial, attenuation of the signal generated by photodiode **PH** that reaches amplifier **A1**. As hereinafter more clearly explained, this portion of the circuit prevents noise signals - with intensity and duration equal to or greater than those of an activation signal - arriving for example from a fluorescent lamp, from causing the unwanted and prolonged power supply of logic **L**.

The operation of the circuit shown in figure 5 is now explained with reference to figures 6, 7 and 8 that illustrate the trend of the signals in three different

circumstances. In figures 6, 7 and 8 too, for the sake of simplicity and clarity, the graphs representing signals **VA1** and **VC1** have interruptions and a different time scale with respect to the other graphs.

By assuming that, at a specific moment in time, transistor **MF1** is substantially held off (i.e. voltage **VA2** is held at low level) - because photodiode **PH** has not received any previous signals - and the circuits are in a stand-by state, the arrival of a signal with sufficient intensity and duration received by photodiode **PH** generates a sequence of pulses **VC1** (see figure 6) that, initially, is similar to the sequence of figure 4.

The signal **VC1** is sent to both filters **F1** and **F2** and, because filter **F1** has a time constant lower than that of filter **F2**, before value **VF2** reaches threshold **VTH3**, the power supply of logic **L** is enabled and so is the checking of the frequency and the duration of sequence **VC1**: if the signal that photodiode **PH** has received and, as a consequence, signal **VC1** do not have the attributes in terms of frequency and duration (minimum number of pulses) of an activation signal, signal **VL** remains at low logic level and the circuits **T** for generating and transmitting optical signals are not powered.

When signal **VF2** reaches the threshold value **VTH3** after a limited delay time **t1** (for example, a few tenths of a second) and, after another very short delay time, the voltage level of the signal **VA2** provided by amplifier **A2** is sufficiently high, transistor **MF1** starts to conduct, thereby causing an attenuation of the voltage across source and drain.

Therefore, as soon as transistor **MF1** starts to conduct, the amplitudes of the signals at the input and at the output of amplifier **A1** are reduced. As a consequence, the duty-cycle of signal **VC1**, outputted by comparator **C1**, reduces owing to the fact that the time intervals in which the amplitude of **VA1** exceeds the threshold value **VTH1** become shorter. Thus, output voltage **VF1** of filter **F1** decreases and stabilizes at

a value that is slightly higher than the threshold value **VTH3** (and thus lower than the value of **VTH2**). The output voltage **VF2** also stabilizes at this value so as to keep voltage **VA2** sufficiently high, and thus the voltage at the input of amplifier **A1** suitably attenuated. When the value of voltage **VF1** becomes lower than the threshold value **VTH2** of comparator **C2**, the value of signal **VC2** switches to low logic level and, if an activation signal has not been identified in the meantime, the power supply **VA** of logic **L** is inhibited and remains so as long as the noise signals persist (or when these signals stop), thereby preventing a needless consumption of the energy of battery **12**. Conversely, if the activation signal is in the meantime identified, the subsequent switching of the value of signal **VL** to a high level ensures the maintaining of the full power supply.

Figure 7 shows the trend of the signals when a proper activation signal is sent to photodiode **PH** together with noise signals as those referred to in figure 6. It is assumed that when the proper activation signal is received by photodiode **PH**, the value of voltage **VA2** and the conduction of transistor **MF1** are sufficient for keeping the circuits in a stand-by state, thanks to the previously described performance.

The arrival of the activation signal - that overlaps the noises and has an intensity that is sharply greater than that of the noises - causes an abrupt increase in the amplitude of the signal generated by photodiode **PH** and in the amplitude of the amplified signal **VA1**. Notwithstanding the attenuation effect of transistor **MF1**, the duty-cycle of the sequence of pulses **VC1** output by comparator **C1** increases, signal **VF1**, outputted by filter **F1**, exceeds the threshold value **VTH2** and signal **VC2** switches to high logic level, thereby enabling the power supply of logic **L** and the checking of the frequency and duration attributes of the received signal. The value of signal **VF2**, output by filter **F2**, also slightly increases, but more slowly, thanks to the

different time constant RC2, and the value of voltage **VA2** increases in the same way. It should be noted that, unlike what has been shown for the sake of simplicity and clarity in figure 7, the variations of signal **VA2** are of a definitely greater entity (that depends on the gain of amplifier **A2**) with respect to those of signal **VF2**. The increase in the value of voltage **VA2** causes, through the action of transistor **MF1**, a greater attenuation of the signal of photodiode **PH**, that is sufficient for bringing the output of filter **F1** back to a value that is just slightly higher than **VTH3**. However, before this takes place, signal **VC2** remains at high logic level so as to enable the power supply for a time interval that is sufficient for permitting logic **L** to recognize the frequency and the duration attributes of the activation signal and switch the level of signal **VL** in order to maintain the power supply even after the decrease of signal **VC2** as a consequence of the automatic sensitivity control.

It should be noted that, in the event the increase in the amplitude of the voltage generated by photodiode **PH** were also to be caused by an unwanted noise signal, for example owing to a sudden displacement between probe **4** and a fluorescent lamp, the consequent supply of logic **L** would be in any case of short duration (as the situation referred to in figure 6).

It should furthermore be noted that the trend of signal **VF1**, shown in figure 7, indicates a further decrease, below threshold **VTH3**, for a short time interval that follows the end of the activation signal, when there is still considerable attenuation, and the subsequent return to a value slightly higher than threshold **VTH3** further to a drop (decrease of **VF2** and **VA2**) of the attenuation, yet sufficient for "filtering" noise signals.

Figure 8 represents the situation in which a deactivation signal is sent by stationary transceiver unit **10** in the following circumstances:

1) probe **4** is performing a checking cycle and thus there is full power supply to the circuits (**VL** is at high logic level), and

2) the noise signals received by photodiode **PH** cause the attenuation of the signal that photodiode **PH** generates in accordance with the previously described performance, thereby preventing the sequence of pulses **VC1** from reaching logic **L** (**VC2** is at low logic level).

The freshly input signal, the intensity of which is particularly high, overlaps the noises and causes an abrupt increase in the amplitude of the signal generated by photodiode **PH**. The performance shown in figure 8 is similar to that of the example shown in figure 7, and signal **VC2** is switched to high logic level and remains so for a short period of time, before the signal of photodiode **PH** is suitably attenuated. In this case, the effect of the switching of signal **VC2** is not that of altering the power supply of logic **L** (it is already powered thanks to the action of signal **VL**), but that of enabling - by means of the logic AND circuit **G2** - logic **L** to check the frequency and duration attributes of the freshly input signal. If, on the basis of these checks, there is identified a deactivation signal, the logic level of signal **VL** is switched from high to low in such a way so that, further to the subsequent decrease in the level of signal **VC2** due to the attenuation effect, the power supply of logic **L** (and that of the circuits **T** for generating and transmitting optical signals) is inhibited. On the contrary, the checks end, when signal **VC2** returns to low logic level, if the deactivation signal has not been identified.

Obviously the probability that, in the course of the short time intervals when **VC2** is at high logic level, there be a noise signal with the frequency and duration attributes of an activation signal is extremely low. However, should this unlikely event occur, it could cause the undesired activation of probe **4**, i.e. the undesired full power supply of its circuits.

In an identical (and equally unlikely) manner it could take place that, in the course of short time intervals when **VC2** is at high logic level, there be the reception of a noise signal with the attributes of a deactivation signal that, identified as such, could interrupt the supply of power to the circuits of probe **4** while a checking cycle is taking place and cause foreseeable negative consequences.

By way of experiment it has occurred that, while the fluorescent lamps with electronic reactor emit noises having considerably higher frequencies than the frequencies of the proper activation and deactivation signals, noises emitted by lamps with non-electronic reactor can have frequencies that are closer to those of the former proper signals. Typically the lamps of the second type emit noises with an intensity that periodically takes a value near zero for a relatively non negligible time interval (typically near a millisecond), as the power supply voltage periodically assumes the zero value.

Figure 9 schematically represents filter **F1**, shown in figures 2 and 5, and additional attenuation devices with an additional filtering unit **FA**, connected in parallel to filter **F1**. Filter **F1** and unit **FA** together achieve an "asimmetric" filter **F1'** that enables to solve the problem of undesired activations and deactivations of probe **4**.

Filter **F1'** includes two low pass filters, one **(F1)** consists of resistor **RES1** and capacitor **CON1** and the other consists of resistor **RES2** and capacitor **CON2**. Moreover, unit **FA** includes a comparator **C3**, that compares the signal at its input with a threshold **VTH4**, and a diode **D1**, that, for the sake of simplicity in the description, is considered as ideal. The filter consisting of components **RES2** and **CON2** has a lower time constant with respect to that of filter **F1**.

On reception of a signal with suitable intensity and negligible interruptions, the signal outputted by the filter consisting of **RES2** and **CON2** increases more rapidly with respect to the one outputted by **F1**, until it exceeds

threshold value **VTH4** and switches the output of comparator **C3** to high logic level. Thus diode **D1** is turned off. In this case filter **F1'** substantially acts as filter **F1**, in other words in the manner described with reference to figures 2 and 5. On the contrary, if the received signal has significant interruptions, at every interruption the value of the voltage at the input of comparator **C3** falls below the value of **VTH4**, switching the output of comparator **C3** to low logic level. Thus, diode **D1** periodically conducts and enables the periodic discharge of capacitor **CON1**. As a consequence, signal **VF1** does not reach threshold value **VTH2** and the power supply of logic **L** is not enabled and/or signal **VC1** does not reach logic **L**. Therefore, the use of filter **F1'** in figure 9 in a circuit as the one of figure 2, or figure 5, prevents noise signals with significant interruptions, as those emitted by fluorescent lamps with non-electronic reactor, to cause the even temporary power supply of logic **L** or the even temporary enabling of the signal frequency checks. It should be realized that, as previously mentioned, these noise signals are, among the noises emitted by the fluorescent lamps, those which have frequency and regularity attributes that have a relatively higher probability (even though in absolute very low) of approaching the attributes of the activation and deactivation signals. Thus, as with the use of filter **F1'** the power supply of logic **L** is not even enabled for a limited time or, if the device is in the transmission phase, the checks of the signal frequency are not even enabled for a limited time, substantially there is no risk of possible unwanted activation/deactivation. Obviously, the presence of filter **F1'** in combination with the automatic sensitivity control enabled by the arrangement of figure 5 gives simultaneous protection against the noise signals both at lower frequencies (comparable with the activation/deactivation frequencies) and at higher frequencies (like those emitted by fluorescent lamps with electronic reactor), in the latter case enabling undesired

power supply of just logic **L** for sporadic and very short intervals of time (typically shorter than half a second) that are substantially negligible in view of the correct consumption of energy of battery **12**.

Figure 10 is a schematic and partal diagram of a remote transceiver unit **8** according to another embodiment of the invention.

The circuit comprises, in addition to the components described with reference to figures 5 and 9, a LED **LD** that enables to visually check the state of probe **4** and indicate the presence of noises, and a connection section **SC** that includes: a programming unit **DS**, for example a manually operated switch (or "dip switch") with two selectors, more specifically switches **SW1** and **SW2**, three resistors **RES3**, **RES4**, **RES5**, a comparator **C4** for comparing the signal at its input with a threshold value **VTH5**, and a field effect transistor **MF2**. Furthermore, figure 10 schematically shows the detecting devices **13** (i.e. a microswitch) and the associated connections to the connection section **SC**.

When switch **SW2** is open (it can be operated, for example, in a manual way) and the apparatus is transmitting, the turning on of LED **LD** monitors the deflection of arm **7** as a consequence of contact between feeler **6** and a piece **1**. In fact, when arm **7** is not deflected (there is no contact between feeler **6** and piece **1**), microswitch **13** is closed: in this condition, the signal at the non-inverting input of comparator **C4** is low, thus, transistor **MF2** is held off and LED **LD** is off.

On the contrary, when arm **7** is deflected, microswitch **13** is open and thus at the non-inverting input of comparator **C4** there is a signal that exceeds the threshold value **VTH5** and enables transistor **MF2** to conduct. In this case, the voltage at the ends of LED **LD** causes its turning on for visually displaying that contact between feeler **6** and the surface of piece **1** has taken place. The voltage at the output of comparator **C4** is also sent to logic **L**, that detects that contact has taken place and accordingly drives

the circuits **T** for generating and transmitting optical signals.

If switch **SW2** is closed, when the logic is powered (signal **VA** is at high logic level), transistor **MF2** conducts and LED **LD** is on, regardless of the condition of microswitch **13**. Switch **SW2** can be turned off in the phase of assembly and setting up of probe **4** on machine tool **2** for the purpose of allowing to visually check through LED **LD** whether, in the specific position in which the probe will be mounted on the machine tool, the remote transceiver unit **8** is subject to noises. In fact, in this phase the only cause of the supply of power to logic **L** (signal **VA** is at high logic level), that can be identified by the turning on of LED **LD**, is noises. In the event this occurs, switch **SW1** can be turned off (for example, it can be manually operated), the latter allows signals to be sent to amplifier **A2** and to the additional filtering unit **FA** for enabling the associated automatic sensitivity control and "asimmetric" filtering functions. After a specific time has elapsed from the start of the noise signal, as a consequence of the switching of signal **VA** to low logic level, the turning off of LED **LD** visually monitors that the circuit has provided an efficacious protection against the noises.

When the setting up phase ends, switch **SW2** is opened so LED **LD** can continue to visually monitor the condition of arm **7** of probe **4**. On the contrary, switch **SW1** can be either turned off or on depending on whether - on the basis of the detections made in the setting up phase - it be considered advisable to enable the automatic sensitivity control and "asimmetric" filtering functions for limiting the power supply time periods of logic **L** and minimize unwanted consumption of energy of battery **12** and the risk of unwanted activations and deactivations.

Thus, the so far described embodiments of the remote transceiver unit **8** enable, in a particularly simple and efficacious way, to achieve substantially negligible unwanted consumptions of energy of battery **12** due, for

example, to noise signals that can be emitted by fluorescent lamps, and reduce practically to zero the probability that these noise signals be the cause of an accidental activation or deactivation of probe **4**.

Obviously, the components of unit **8**, herein described and illustrated in an extremely schematic way, can be achieved in various known ways without departing from the scope of the present invention. This also applies to the other units and components shown in the figures, as, for example, the detecting devices **13**, which can include switches or transducers of a known type.

Systems including other aspects with respect to what is herein described, as for example, insofar as the attributes of the activation and deactivation signals identified by the logic are concerned also fall within the scope of the invention. These attributes may include specific codings of the signals, not necessarily bound to frequency and/or duration (number of pulses) of the signals.

Furthermore, even though the figures and the associated description refer to a transceiver system of infrared signals, the present invention can be applied - without substantial modifications - to systems that transmit signals at other frequencies, for example in the radiofrequency range.

CLAIMS

1. A system for detecting linear dimensions of a workpiece **(1)**, including

- a checking probe **(4)** with detecting devices **(13)**,
- a power supply **(12)** connected to the checking probe **(4)**,
- a remote transceiver unit **(8)**, integral with the probe **(4)**, connected to the detecting devices **(13)** and to the power supply **(12)**, and adapted for wireless transmitting signals indicative of the state of the probe **(4)**, and
- a stationary transceiver unit **(10)**, adapted for wireless transmitting activation signals to said remote unit **(8)**,

wherein the remote transceiver unit **(8)** includes receiving devices **(PH)** adapted for receiving the wireless transmitted signals, a processing section **(E)**, connected to the receiving devices **(PH)** and to the power supply **(12)** and adapted for generating an enable signal **(VC2)**, a switching unit **(A)** connected to the processing section **(E)** and to the power supply **(12)**, and additional sections **(L,T)** connected to the switching unit **(A)**, the switching unit being adapted for receiving the enable signal **(VC2)** and, on the basis of this signal, controlling the power supply cf at least some of said additional sections **(L,T)**,

characterized in that the processing section **(E)** includes attenuation devices **(F2,A2,MF1,FA)** adapted for inhibiting the generating of the enable signal **(VC2)** on the basis of attributes of the signal that the receiving devices **(PH)** have wireless received.

2. The system according to claim 1, wherein said attenuation devices include at least a delay generator **(F2)**, for enabling the generating of the enable signal **(VC2)** as the attributes of the signal wireless received by the receiving devices **(PH)** vary and for inhibiting the generating of said enable signal **(VC2)** after a predetermined delay time **(t1)** on the basis of said attributes.

3. The system according to claim 1 or claim 2, wherein the processing section **(E)** includes at least an amplifier **(A1)** connected to the receiving devices **(PH)** for generating an amplified signal **(VA1)**, and the attenuation devices include elements **(F2,A2,MF1)** of a feedback circuit for attenuating the intensity of the amplified signal **(VA1)**.

4. The system according to claim 3, wherein the receiving devices **(PH)** are adapted for transmitting a periodic signal to the amplifier **(A1)**, said feedback circuit **(F2,A2,MF1)** being connected to the input of the amplifier **(A1)** for reducing the amplitude of said periodic signal on the basis of the amplitude of the amplified signal **(VA1)**.

5. The system according to claim 3 or claim 4, wherein said additional sections of the remote transceiver unit **(8)** include a logic processing unit **(L)**, the switching unit **(A)** being connected to the logic processing unit **(L)** for connecting the power supply **(12)** to the logic processing unit **(L)**.

6. The system according to claim 5, wherein the remote transceiver unit **(8)** includes an enable device **(G2)** connected to the processing section **(E)** and to the logic processing unit **(L)** and adapted for receiving said enable signal **(VC2)** for enabling the transmission to the logic processing unit **(L)** of a processed signal **(VC1)** with attributes that match those of the signal wireless received by the receiving devices **(PH)**.

7. The system according to claim 6, wherein said attributes of the processed signal **(VC1)** include frequency and duration.

8. The system according to claim 7, wherein said processing section **(E)** includes a first comparator **(C1)**

connected to said at least one amplifier **(A1)** and adapted for providing said processed signal **(VC1)**, at least a low pass filter **(F1;F1')** connected to the first comparator **(C1)**, a second comparator **(C2)** connected to said at least a low pass filter **(F1;F1')** and adapted for providing said enable signal **(VC2)**, the elements of the feedback circuit including an additional low pass filter **(F2)** connected to the first comparator **(C1)**, an additional amplifier **(A2)** connected to the additional low pass filter **(F2)**, and an attenuation unit **(MF1)** connected to the output of the additional amplifier **(A2)** and to the input of said at least one amplifier **(A1)**.

9. The system according to claim 8, wherein said attenuation unit includes a field effect transistor **(MF1)**.

10 The system according to one of claims from 3 to 7, wherein said processing section **(E)** includes a first comparator **(C1)** connected to said at least one amplifier **(A1)** and adapted for generating a processed signal **(VC1)**, at least a low pass filter **(F1)** connected to the first comparator **(C1)**, and a second comparator **(C2)** adapted for receiving a signal **(VF1)** from said at least one low pass filter **(F1)** and providing said enable signal **(VC2)**, the attenuation devices including an additional filtering unit **(FA)** connected between the first **(C1)** and the second **(C2)** comparator, in parallel to said at least one filter **(F1)**, and adapted for altering the signal **(VF1)** received by said second comparator **(C2)** for detecting interruptions in the processed signal **(VC1)**.

11. The system according to one of the preceding claims, wherein said stationary transceiver unit **(10)** and said remote transceiver unit **(8)** are adapted for transmitting and receiving optical radiations.

12. The system according to claim 11, wherein said stationary transceiver unit **(10)** and said remote transceiver unit **(8)** are adapted for transmitting and receiving optical radiations in the infrared range.

13. The system according to claim 12, wherein the receiving devices include at least a photodiode **(PH)** adapted for receiving infrared radiations and generating a corresponding alternating signal, the processing section **(E)** of the remote transceiver unit **(8)** being adapted for processing said alternating signal for generating the enable signal **(VC2)**.

14. The system according to one of the preceding claims, wherein the remote transceiver unit **(8)** includes a LED **(LD)** and a coupling section **(SC)** between the LED **(LD)**, the switching unit **(A)** and the detecting devices **(13)**, said coupling section **(SC)** including a programming unit **(DS)** with at least a switch **(SW2)**, the LED **(LD)** being adapted for visually and alternatively indicating modifications in the state of the probe **(4)** or in the power supply condition of the probe **(4)**.

15. The system according to claim 14, wherein the programming unit **(DS)** is of the manually operated type and includes at least an additional switch **(SW1)**, connected to the switching unit **(A)** and to the attenuation devices **(A2,FA)**, for enabling or inhibiting said attenuation devices **(A2,FA)**.

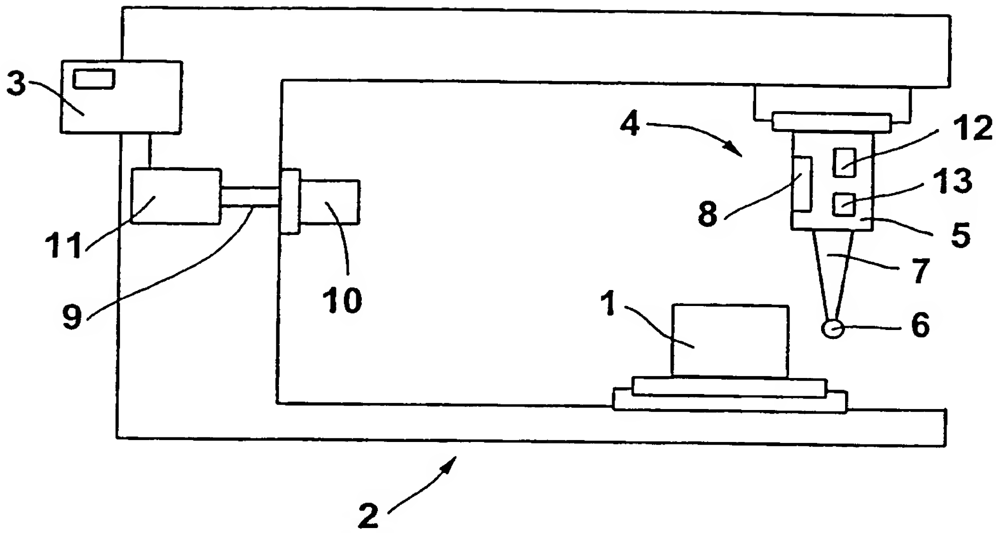


FIG.1

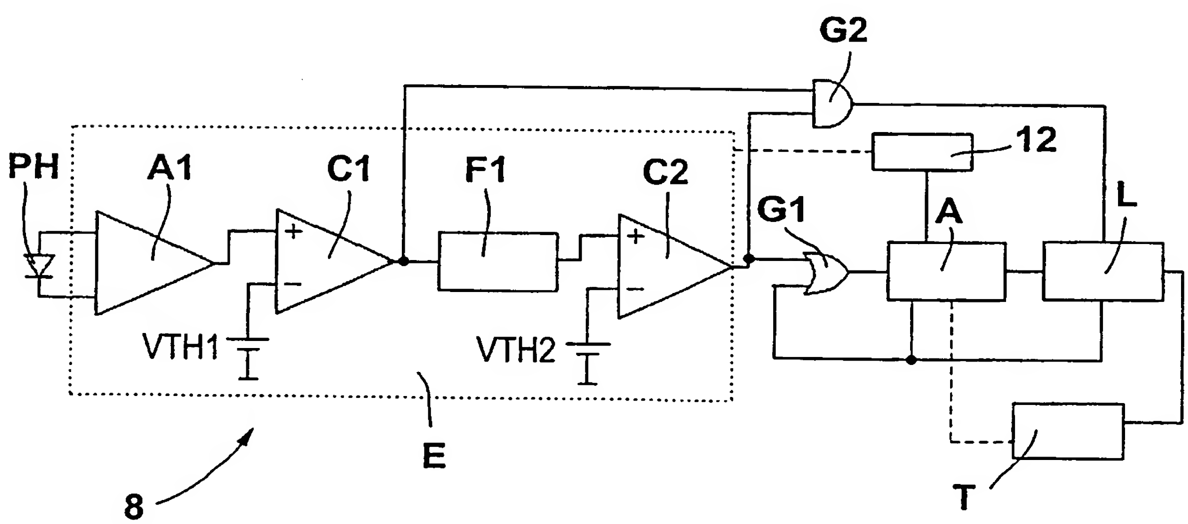


FIG.2

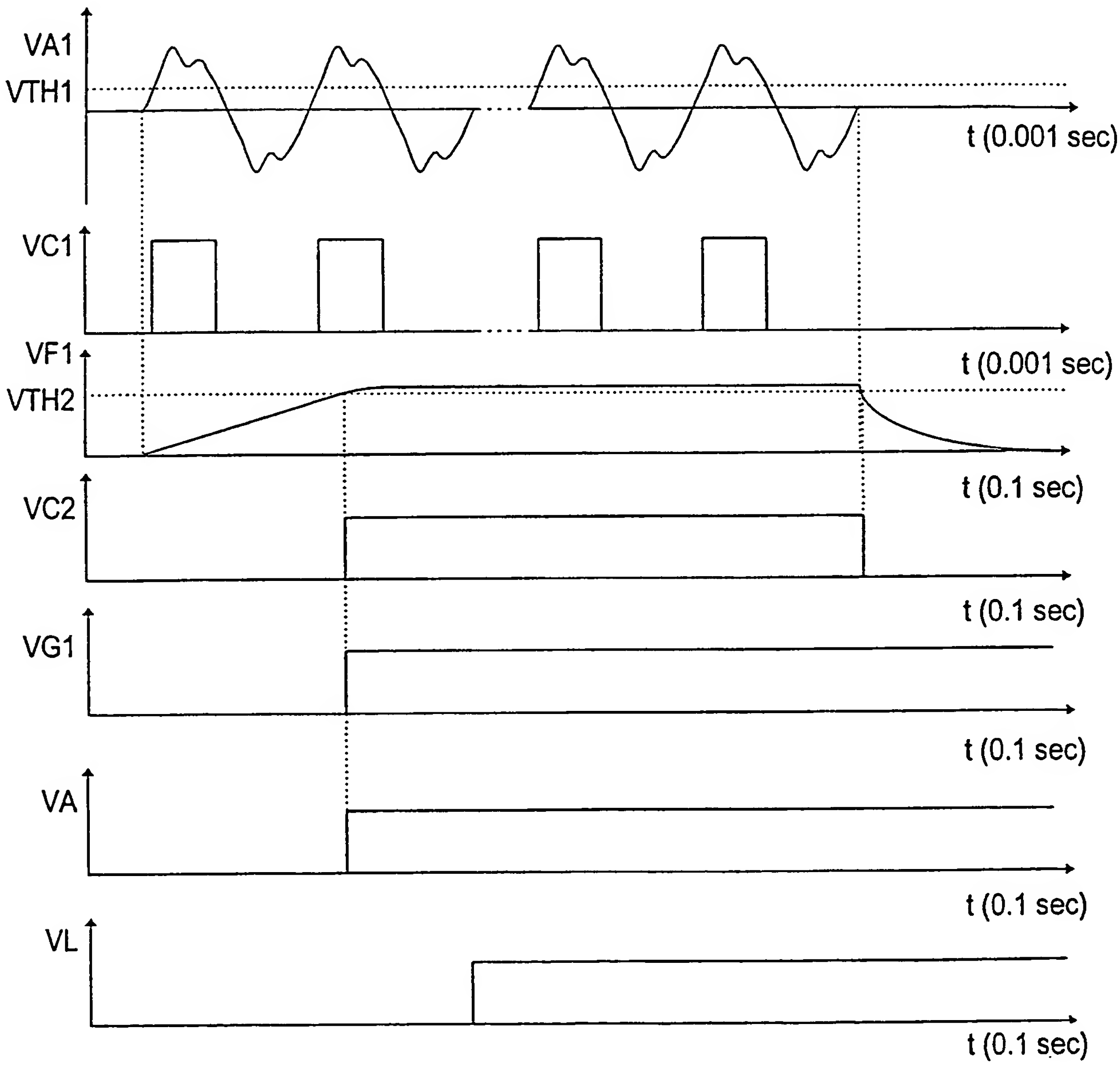

VA1
VTH1
t (0.001 sec)
VC1
VF1
t (0.001 sec)
VTH2
t (0.1 sec)
VC2
t (0.1 sec)
VG1
t (0.1 sec)
VA
t (0.1 sec)
VL
t (0.1 sec)

FIG.3

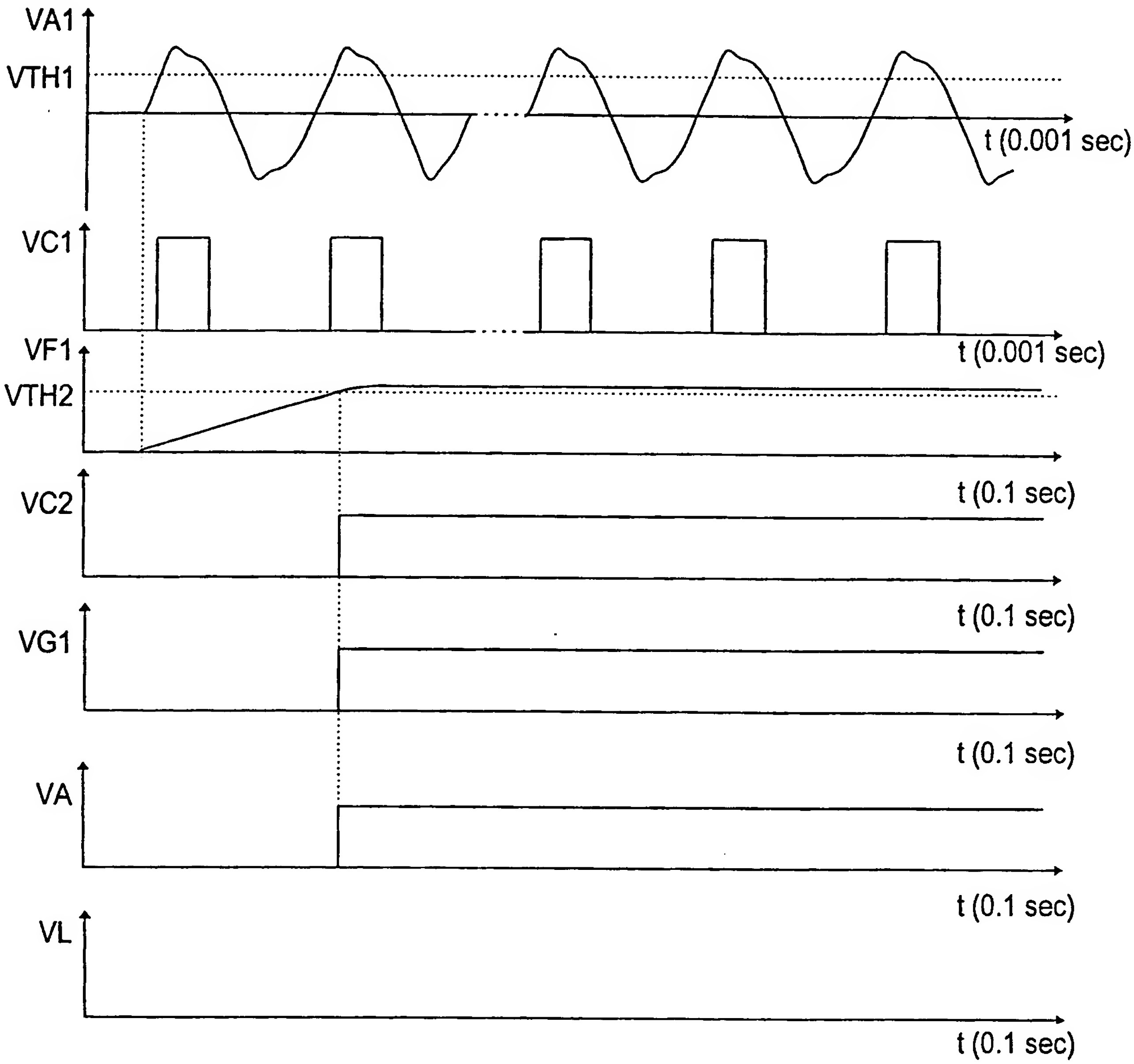

VA1
VTH1
t (0.001 sec)
VC1
VF1
t (0.001 sec)
VTH2
VC2
t (0.1 sec)
VG1
t (0.1 sec)
t (0.1 sec)
VA
t (0.1 sec)
VL
t (0.1 sec)

FIG.4

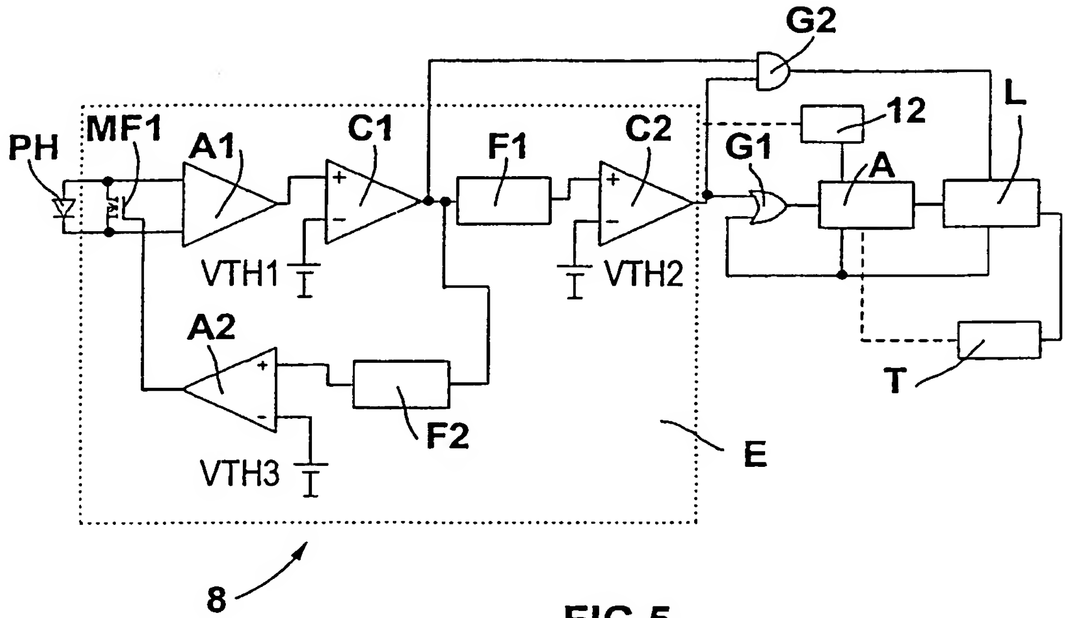

G2
12
L
PH
MF1
A1
C1
F1
C2
G1
A
VTH1
VTH2
A2
T
F2
E
VTH3
8

FIG.5

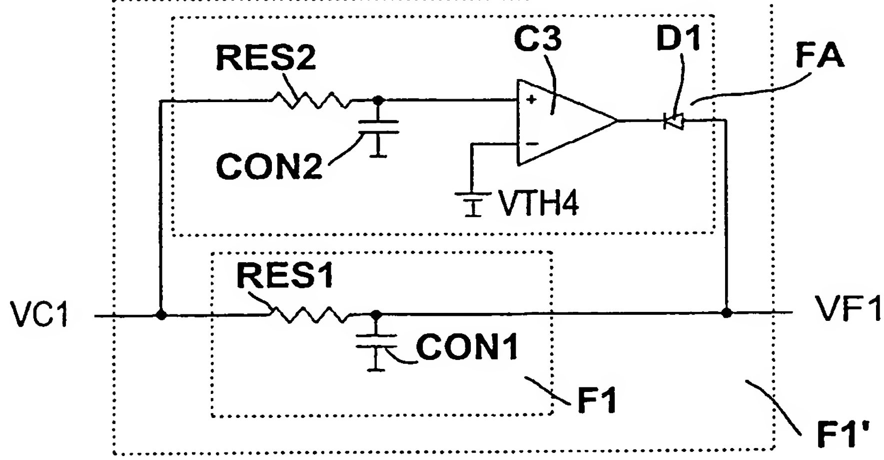
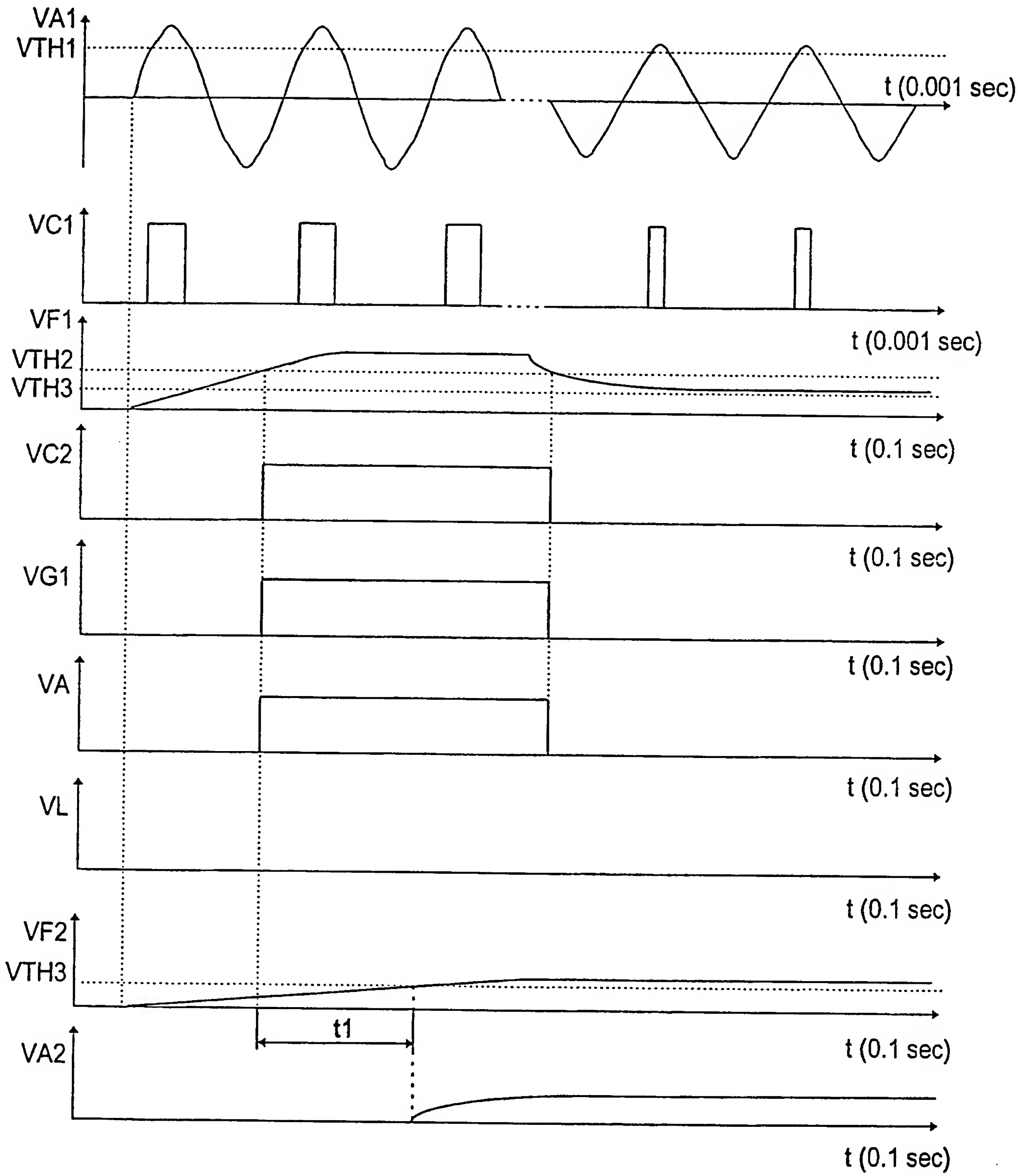

C3
D1
FA
RES2
CON2
VTH4
RES1
VC1
VF1
CON1
F1
F1'

FIG.9



VA1
VTH1
t (0.001 sec)
VC1
VF1
t (0.001 sec)
VTH2
VTH3
VC2
t (0.1 sec)
VG1
t (0.1 sec)
VA
t (0.1 sec)
VL
t (0.1 sec)
VF2
t (0.1 sec)
VTH3
t1
VA2
t (0.1 sec)
t (0.1 sec)

FIG.6

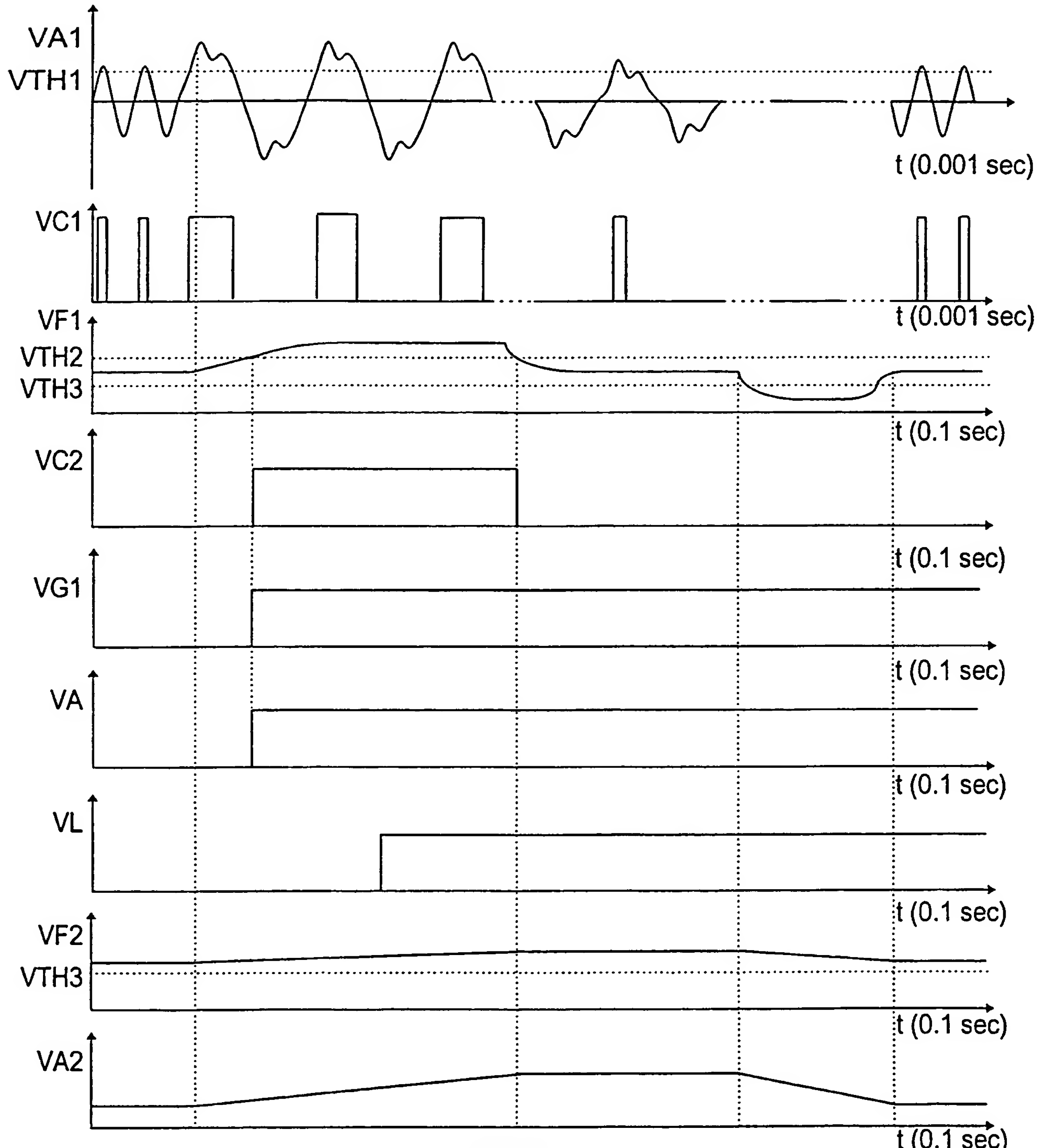

VA1
VTH1
t (0.001 sec)
VC1
t (0.001 sec)
VF1
VTH2
VTH3
t (0.1 sec)
VC2
t (0.1 sec)
VG1
t (0.1 sec)
VA
t (0.1 sec)
VL
t (0.1 sec)
VF2
VTH3
t (0.1 sec)
VA2
t (0.1 sec)

FIG.7

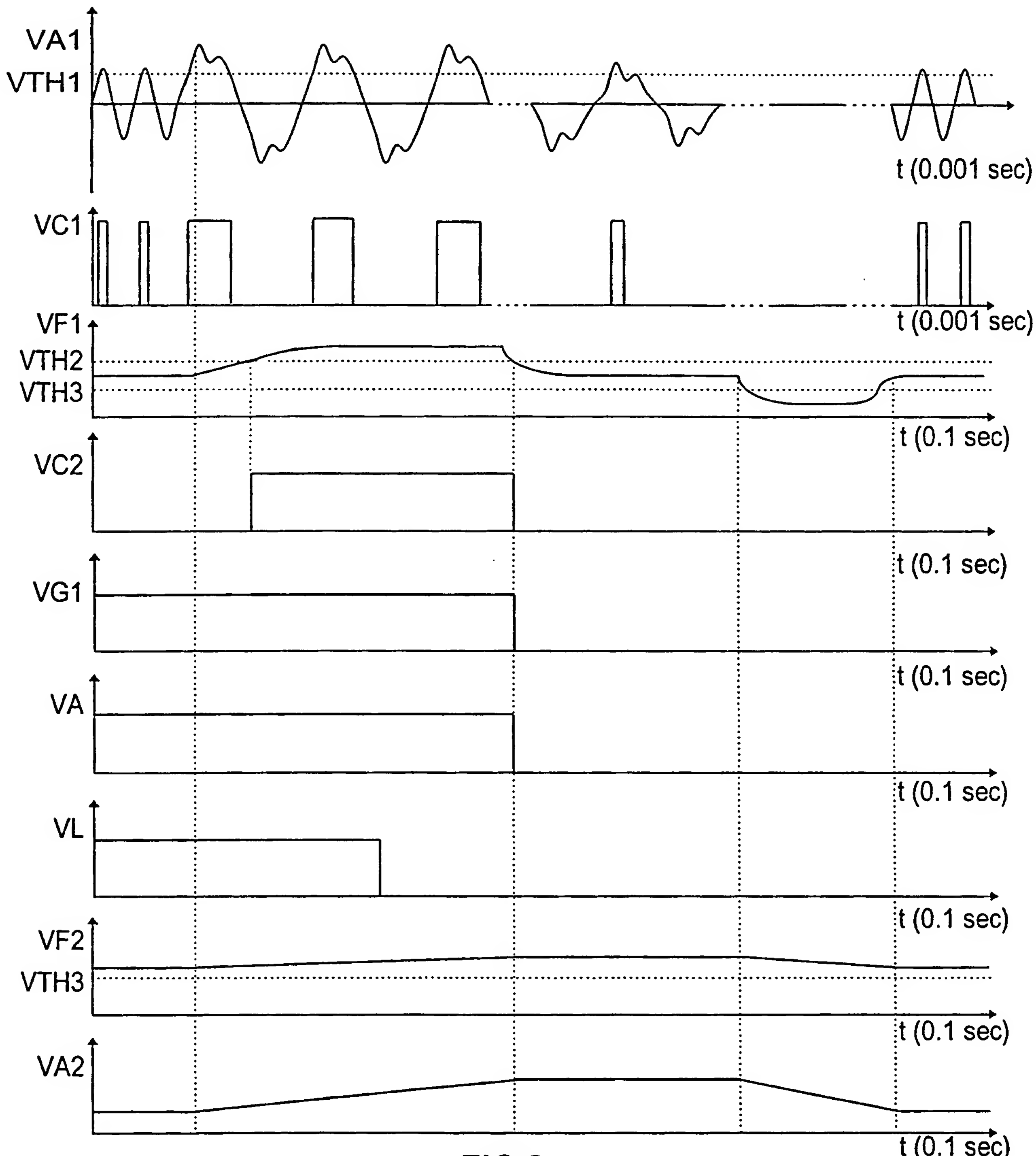

VA1
VTH1
t (0.001 sec)
VC1
t (0.001 sec)
VF1
VTH2
VTH3
t (0.1 sec)
VC2
t (0.1 sec)
VG1
t (0.1 sec)
VA
t (0.1 sec)
VL
t (0.1 sec)
VF2
VTH3
t (0.1 sec)
VA2
t (0.1 sec)

FIG.8

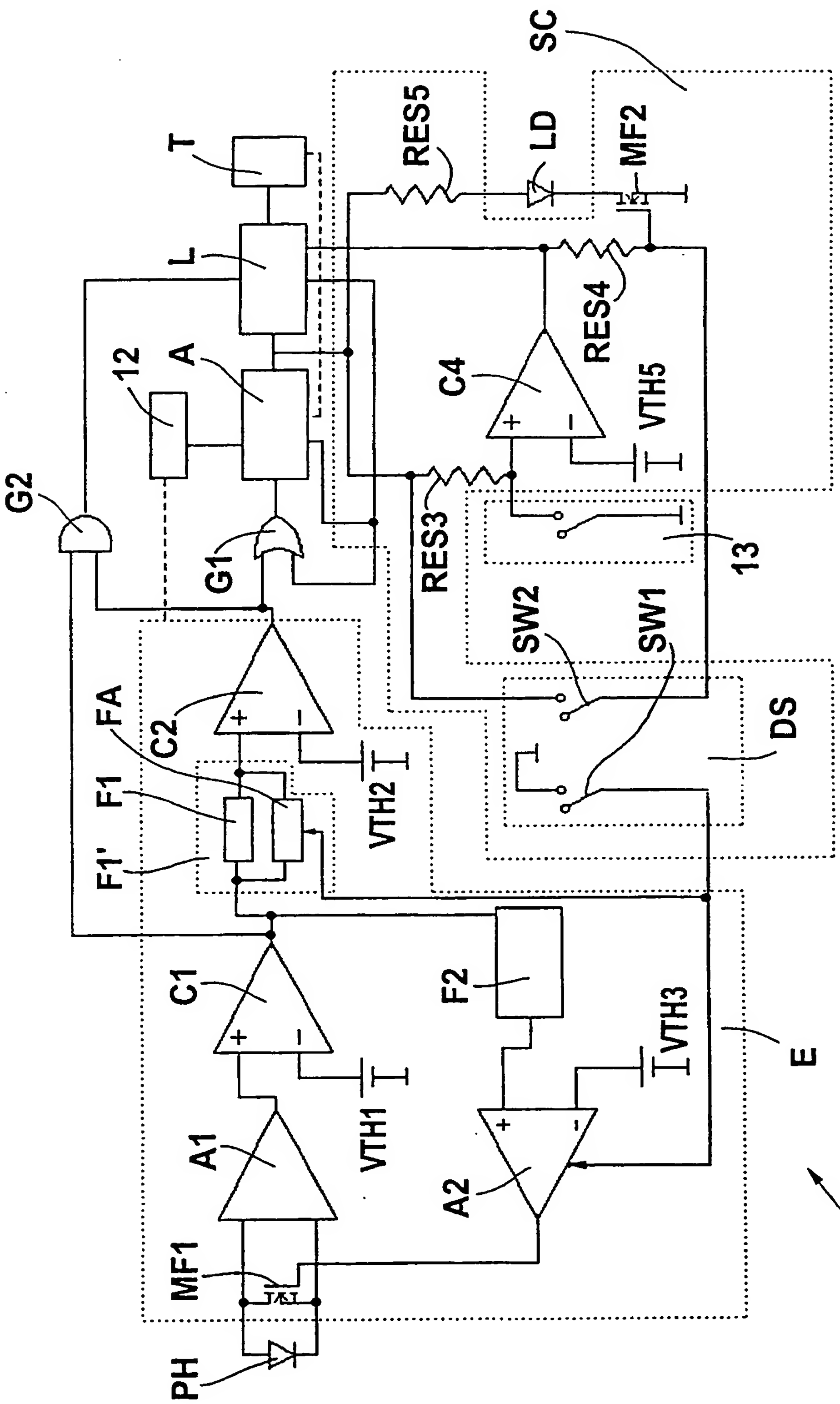

SC
T
RES5
LD
MF2
L
RES4
12
A
C4
VTH5
G2
G1
RES3
13
SW2
SW1
FA
C2
F1
F1'
VTH2
DS
C1
F2
VTH3
E
A1
VTH1
A2
MF1
PH
8

FIG.10

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 00/04052

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G01B7/02 B23Q17/20

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G01B B23Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

WPI Data, EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 2 141 364 A (GTE VALERON CORP) 19 December 1984 (1984-12-19) page 3 -page 6	1-15
A	US 5 056 049 A (O'NEILL TIMOTHY P) 8 October 1991 (1991-10-08) claims 1-50	1-15
A	PATENT ABSTRACTS OF JAPAN vol. 1995, no. 06, 31 July 1995 (1995-07-31) & JP 07 055451 A (NIKON CORP), 3 March 1995 (1995-03-03) abstract	1

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 July 2000	04/08/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Dietrich, A

1

INTERNATIONAL SEARCH REPORT

Int tional Application No
PCT/EP 00/04052

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	PATENT ABSTRACTS OF JAPAN vol. 016, no. 203 (M-1247), 14 May 1992 (1992-05-14) & JP 04 030949 A (MITSUI SEIKI KOGYO CO LTD), 3 February 1992 (1992-02-03) abstract ---	1
A	PATENT ABSTRACTS OF JAPAN vol. 010, no. 060 (P-435), 11 March 1986 (1986-03-11) & JP 60 202302 A (YUNII DEETA SYSTEM:KK), 12 October 1985 (1985-10-12) abstract -----	1

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/EP 00/04052

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GB 2141364	A	19-12-1984	US	4509266	A	09-04-1985
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			AU	2740484	A	20-12-1984
			BE	899914	A	01-10-1984
			CA	1234893	A	05-04-1988
			DE	3422180	A	20-12-1984
			FR	2548350	A	04-01-1985
			IT	1209554	B	30-08-1989
			KR	9002676	B	23-04-1990
			MX	155137	A	29-01-1988
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			SE	8403157	A	15-12-1984
			ZA	8403831	A	29-01-1986
US 5056049	A	08-10-1991	NONE			
JP 07055451	A	03-03-1995	NONE			
JP 04030949	A	03-02-1992	NONE			
JP 60202302	A	12-10-1985	NONE			